4. Existing Biophysical Environment

4.1 Climate

The northern Pilbara region of Western Australia is described as arid with wet summers, and waterways are typically ephemeral, generally flowing only a few times a year. The climate is characterised by seasonally low and unreliable rainfall, with an annual average of 300 mm combined with very high temperatures and high diurnal temperature variations (Kendrick and McKenzie, 2001). Rainfall decreases with distance from the coast and can also be influenced by local topography. The two specific weather phenomena that are of the greatest importance to the region are:

- The summer monsoon that brings regular annual rainfall; and
- Tropical cyclones which are associated with very large rainfall events, damaging winds and flooding.

Climatic data provided by the Bureau of Meteorology (http://www.bom.gov.au/) for Marble Bar, the closest weather station to the project, is provided in **Table 4-1**.

4.1.1 Temperature and Humidity

There are generally two main seasons for the region, a hot summer extending from October to April and a mild winter from May to September.

The mean annual maximum and minimum temperatures for Marble Bar are 35.3ºC and 19.9ºC respectively. The mean daily maximum temperature varies from 26.8ºC in July to 41.6ºC in December while the mean minimum daily temperature ranges from 11.8ºC in July to 26.1ºC in January (BOM, 2005). The annual mean relative humidity for Marble Bar is 37% at 9am and decreases to 23% at 3pm. Over a 12 month period Marble Bar averages 98 days above 40ºC and 275 days above 30ºC (Van Vreeswyk et al., 2004).

4.1.2 Rainfall and Evaporation

The Pilbara region has a highly variable rainfall which is dominated by tropical cyclone activity in the summer. The moist tropical storms penetrating from the north bring irregular and heavy thunderstorms and cyclone activity.

Rainfall in the region is seasonal, usually peaking once per year. The rainfall peak is from January to March due to tropical thunderstorms and cyclonic activity where the highest mean monthly rainfall occurs for the year. Mean monthly rainfall varies from 0.9mm in September to 87.8mm in February (**Figure 4-1**). The annual average rainfall is 359.9mm with an average of approximately 36 rain days.

Mean daily pan evaporation ranges from a minimum of 5.3mm in July to a maximum of 12.8mm in December.

- **Table 4-1 Summary of Climatic Data for Marble Bar**

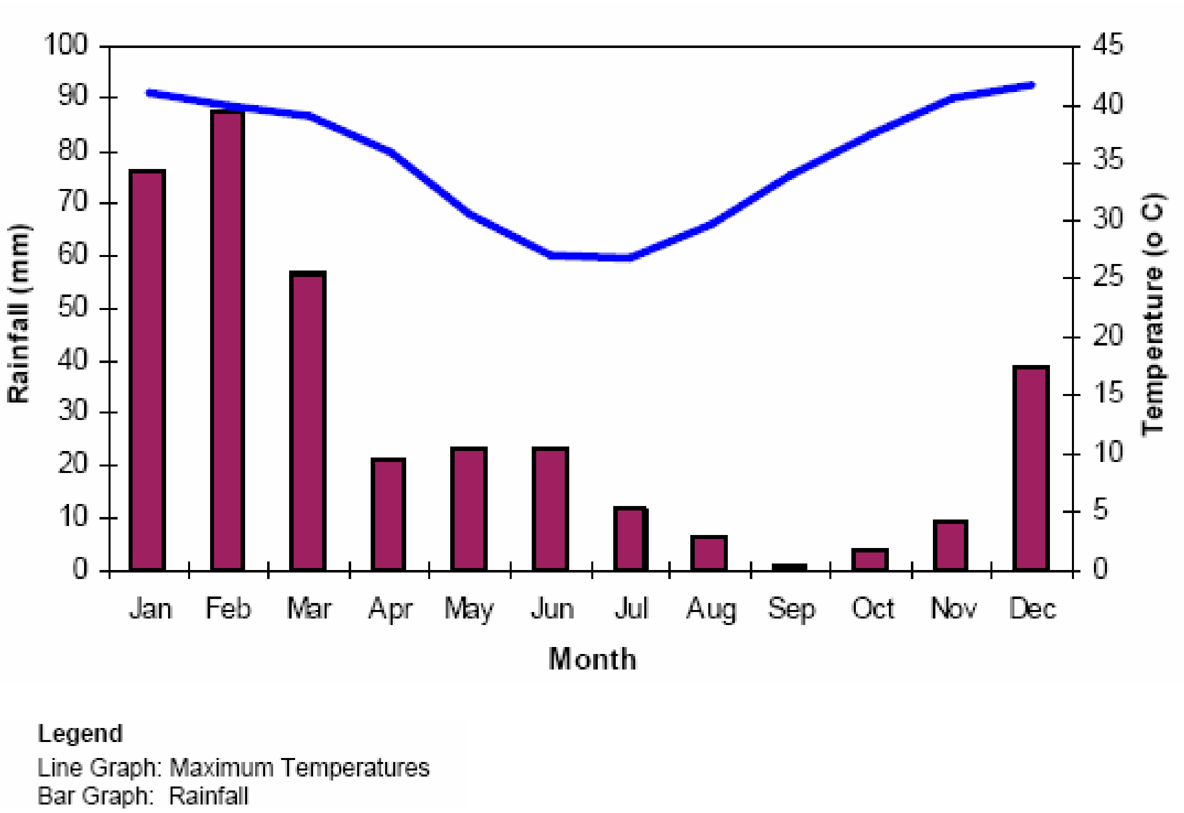
Month	Temperature (°C)		Relative Humidity (%)		Pan Evaporation (mm)	Rainfall (mm)	
	Mean Daily Maximum	Mean Daily Minimum	9am Mean	3pm Mean	Mean Daily	Mean	Mean No. of Rain Days
January	41.0	26.1	45	27	11.2	76.2	7.4
February	39.8	25.6	50	31	10.1	87.8	7.6
March	39.0	24.7	41	25	9.5	56.6	4.9
April	36.0	21.3	35	24	8.4	21.1	1.9
May	30.7	16.6	40	27	6.4	23.3	2.4
June	27.1	13.1	43	28	5.5	23.3	2.3
July	26.8	11.8	39	24	5.3	12.0	1.5
August	29.6	13.3	33	21	6.4	6.6	0.9
September	33.9	16.7	27	17	8.7	0.9	0.3
October	37.5	20.3	26	16	11.0	3.9	0.6
November	40.5	23.6	27	16	12.7	9.2	1.5
December	41.6	25.5	34	20	12.8	39.1	4.6
Annual Mean	**35.3**	**19.9**	**37**	**23**	**9.0**	**359.9**	**35.9**

4.1.3 Wind

Winds during winter are predominantly easterlies, tending to northerlies and norwesterlies during summer. Average wind speeds range from 11.1km/hr to 14.2km/hr in winter; however, maximum wind gusts from these directions can get up to 63.0km/hr during storms (BOM, 2006). Average wind speeds range from 10.2km/hr to 11.9km/hr in the summer months. The annual mean wind speed decreases from morning to afternoon in Marble Bar (BOM, 2006).

4.1.4 Cyclones

Tropical cyclones in the region generally form over the Indian Ocean and Timor Sea penetrating south into the Kimberley and Pilbara regions of Western Australia, rendering this the most cyclone-prone area in Australia. The most active months for tropical cyclones in the Pilbara region are mid-December to April with an average frequency of two cyclones per year crossing the Pilbara coast, one of which is severe (BOM, 2006). During cyclones, wind speeds are likely to reach up to 250km/hr with torrential rain occurring. Although tropical cyclones in the Pilbara region are considered a significant environmental risk in coastal areas, with respect to Marble Bar and the project area, the risk of environmental damage to these inland areas is not as high.



- Figure 4-1 Climate Data for Marble Bar

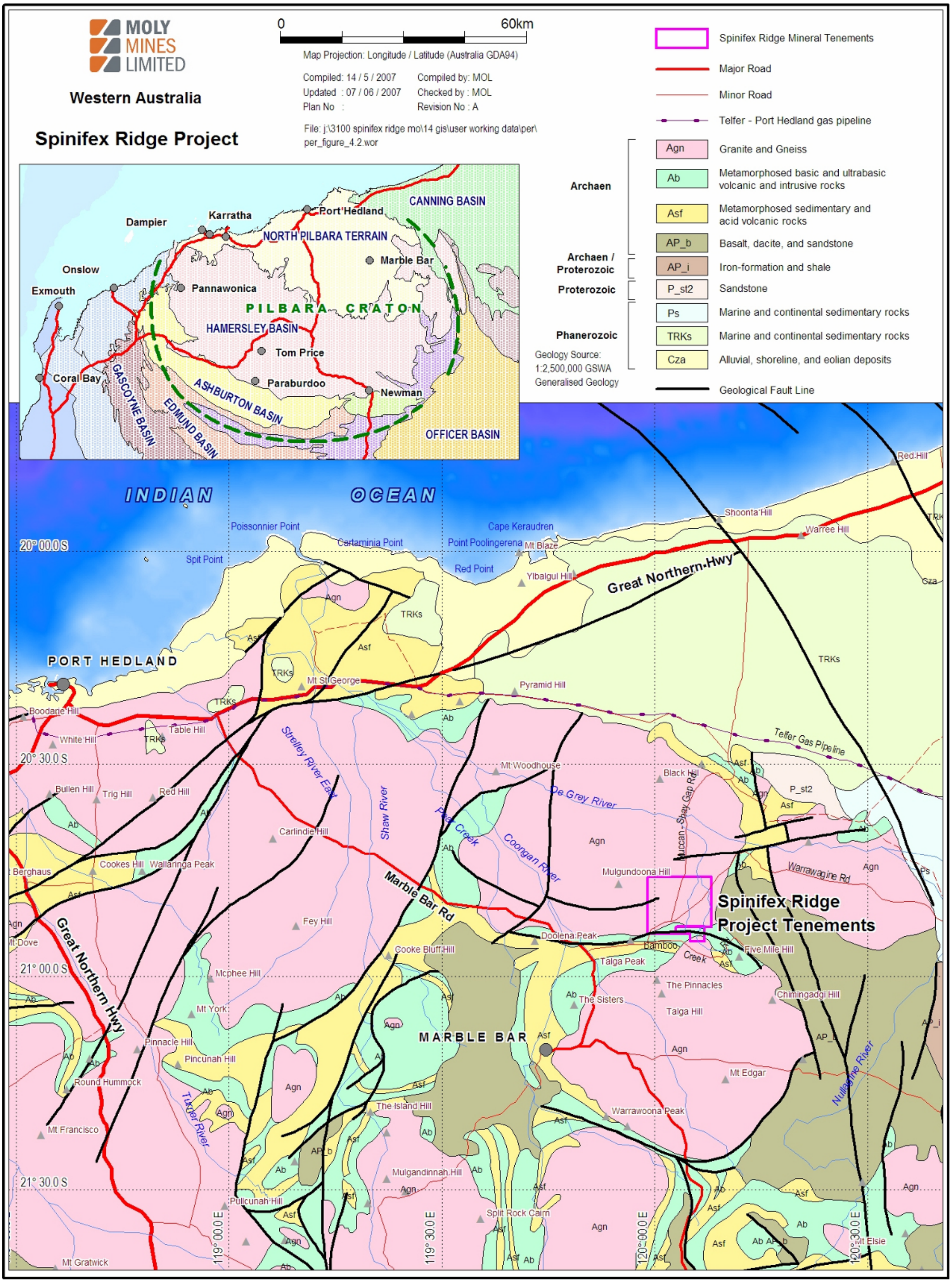
4.2 Geology

4.2.1 Regional Geology

The project is located within the Archaean Pilbara Craton of north Western Australia, specifically in the Eastern Pilbara Granite – Greenstone Terrane (**Figure 4-2**). The Pilbara Craton is divided into two tectonically distinct terranes: (i) the older granite-greenstones that host a wide variety of precious and base metal deposits, including Spinifex Ridge; and (ii) the younger Hamersley Basin that host the bulk of the major iron-ore deposits.

The Pilbara granite-greenstone terrane is dominated by large domal granites intruding an older succession of greenstones consisting of metamorphosed basaltic, ultramafic and felsic volcaniclastic units. These units are commonly overlain and interbedded with clastic sediments consisting of cherts, siltstone, sandstone and minor banded iron formations (BIF). Typically these granites, which include monzogranite, syenogranite, granodiorite and migmatite, have formed domes approximating anticlines whilst the greenstone belts form thin, often strongly attenuated synclines between the granites. Blake and McNaughton (1984) isotopically dated the greenstones to between 3.6Ga and 2.8Ga. The granites have a range of intrusion dates between 3.3Ga and 2.6Ga.

The project is located in the arcuate Marble Bar greenstone belt between the Mount Edgar Batholith to the south and the Muccan Batholith to the north.



▪ **Figure 4-2 Geological Map of the Pilbara Region**

4.2.2 Spinifex Ridge Geology

Molybdenum-copper mineralisation at Spinifex Ridge is related to a structurally controlled intrusive porphyritic granodiorite that has intruded the Marble Bar Archaean Greenstone sequence of mafic (**Plate 4-1**) and felsic (**Plate 4-2**) volcanic rocks. The granodiorite (**Plate 4-3**) has generated an extensive alteration halo dominated by quartz stockworking within which the molybdenum and copper mineralisation occurs as vein-hosted molybdenite and chalcopyrite.

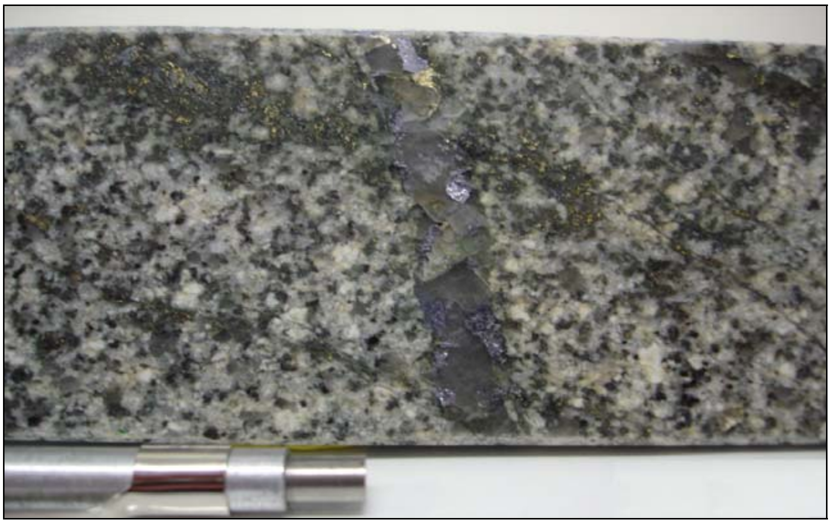
Mineralisation comprises a complex series of multiphase stockwork veins, which contain coarse molybdenum and copper sulphide grains. The stockworking is intense and molybdenum grades tend to increase with increasing vein density. As well as being vein related, disseminated copper sulphides are also formed in the granodiorite wallrock. A schematic mineralisation model is provided in **Figure 4-3**.

The dominant ore carrying sulphide species are molybdenite and chalcopyrite. Silver is closely related to copper, possibly substituting into the matrices of tetrahedrite. Non-ore sulphides include pyrrhotite and subordinately pyrite/marcasite which often form in the interstitial regions of the pillow lavas.

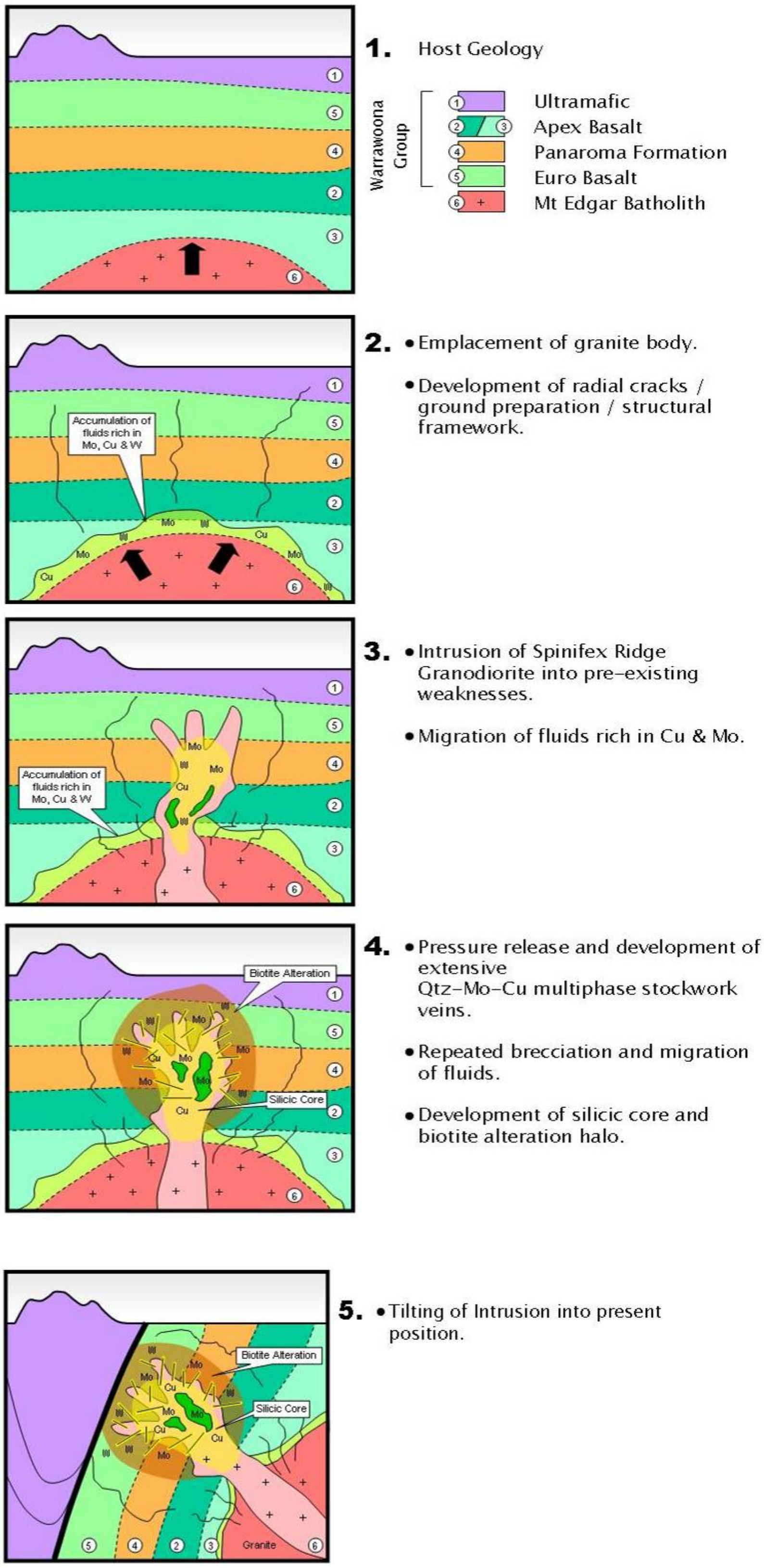
The Spinifex Ridge deposit is situated at the apex of the Coppin Gap Granodiorite, part of the Mt Edgar Batholith. The emplacement of the Coppin Gap granodiorite created the fault system into which the younger mineralised granodiorite was intruded, subsequently depositing the molybdenum and copper mineralisation. The granodiorite intrusion has sharp sub-vertical and often brecciated contacts which are interpreted to represent the controlling fault zones, although the distribution of molybdenum and copper overprints these structures. **Figure 4-4** illustrates an indicative cross section of the orebody.

- **Plate 4-1 Mafic – basalt, pillowed basalt and dolerite**

- **Plate 4-2 Felsic – quartz or feldspar dominated porphyry, rhyolites, dacites and rhyodacites**



- **Plate 4-3 Granodiorite – medium grained to porphyritic granodiorite**



■ **Figure 4-3 Schematic Mineralisation Model**

4.3 Landforms and Soils

4.3.1 Land Systems

A regional land survey of the Pilbara region undertaken between 1995 and 1999 (Van Vreeswyk *et al.* 2004) identified a total of 102 land systems. Fifteen of these land systems are represented within the proposed project area, water supply areas and service corridors.

4.3.1.1 Project Area

The project area is located across four land systems, namely Capricorn (**Plate 4-4**), Macroy (**Plate 4-5**), Rocklea (**Plate 4-6**) and Talga (Van Vreeswyk *et al.* 2004). These land systems vary in regard to landform, geology, and vegetation, and in their proportions within the Pilbara region and the project area (**Table 4-2**).

- **Table 4-2 Land Systems of the Pilbara that occur within the Project Area.**

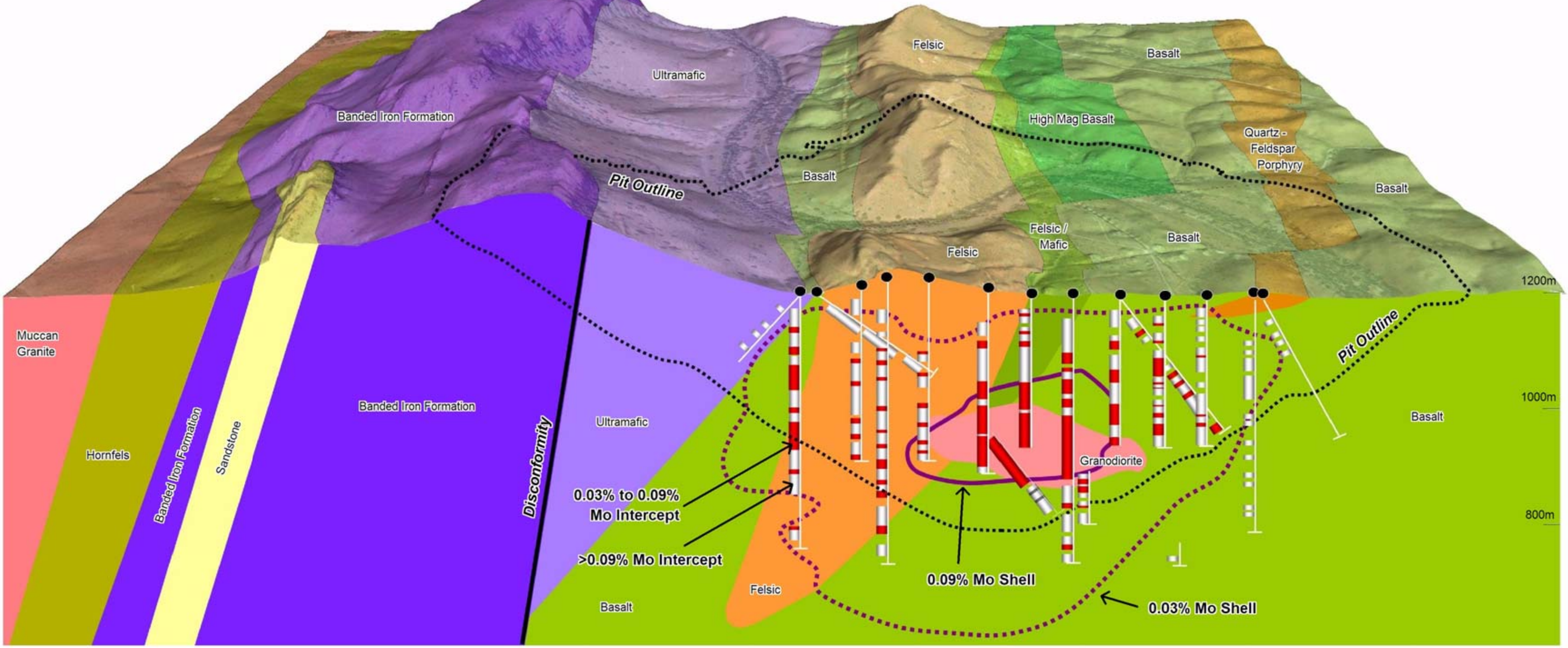
(Van Vreeswyk *et al.* 2004)

Land System	Total Area in Pilbara (km^2)	Proportion of Pilbara (%)	Description and General Distribution	Predominant location over Project Area	Area to be disturbed (km^2)
Capricorn	5,296	2.9	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasses. Widespread, common.	Talga Range and areas immediately adjacent.	2.0
Macroy	13,095	7.2	Stony plains and occasional 8 fields based on granite supporting hard and soft spinifex grasslands. Central north, very common.	Extensive plains both to the north and south of the Talga Range.	11.1
Rocklea	22,993	12.7	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands. Widespread, very common.	Basalt hills immediately south of Capricorn system to the eastern side of the project area. The deposit is within this system.	2.2
Talga	2,124	1.2	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands. North-central, common.	Hills immediately south of Capricorn system to the western side of the project area.	0.4

The Macroy land system dominates the plains of the northern and southern portions of the project area, with the Capricorn land system comprising the major ridge. Directly south of the Capricorn system lies a junction of the Talga land system from the west, and the Rocklea land system from the east.

4.3.1.2 Borefields and Service Corridors

The proposed pipeline corridors to the Canning borefield, De Grey borefield and Woodie Woodie mine site pass through fifteen land systems as identified by Van Vreeswyk *et al.* (2004) (**Table 4-3**).



MOLY
MINES
LIMITED

Spinifex Ridge Project
Western Australia

Figure 4-4
Indicative Cross Section
of the Orebody

0 300m

Map Projection: MGA 51 (GDA94)

Compiled: 16 / 7 / 2007	Compiled by: MOL
Updated : 16 / 07 / 2007	Checked by : MOL
Plan No :	Revision No : A

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- **Table 4-3 Land Systems of the Pilbara that occur within the Pipeline Corridors.**

(Van Vreeswyk *et al.* 2004).

Land System	Total Area in Pilbara (km^2)	Proportion of Pilbara (%)	Description and General Distribution	Max area of De Grey borefield and corridor (km^2)	Max area of Woodie Woodie Corridor (km^2)	Max area of Canning borefield and corridor (km^2)
Boolgeeda	7,748	4.3	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands. Widespread, common.	--	0.2	--
Callawa	1,003	0.6	Highly dissected low hills, mesas and gravelly plains of sandstone and conglomerate supporting soft and hard spinifex grasslands. Scattered in the north.	--	--	0.1
Capricorn	5,296	2.9	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasses. Widespread, common.	--	0.0	0.0
Macroy	13,095	7.2	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands. Central north, very common.	0.3	1.0	0.4
Mallina	2,557	1.4	Sandy surfaced alluvial plains supporting soft spinifex (and occasionally hard spinifex) grasslands. Mostly central north, common.	0.2	0.2	0.2
Nita	11,250	6.2	Sandplains supporting shrubby soft spinifex grasslands with occasional trees. Widespread and common in the north.	--	--	0.2
Oakover	1,529	0.8	Breakaways, mesas, plateaux and stony plains of calcrete supporting hard spinifex grasslands. Mostly central east, sparse.	--	0.3	--
Paradise	1,479	0.8	Alluvial plains supporting soft spinifex grasslands and tussock grasslands. Central north, sparse.	--	0.0	0.1
Paterson	818	0.5	Stony and sandy plains with isolated low hills of sandstone or conglomerate supporting hard spinifex (and occasionally soft spinifex) grasslands and minor tussock grasslands Central east, sparse.	--	1.0	--
Pullgarah	563	0.3	Alluvial plains supporting tussock grasslands and soft spinifex grasslands. North east, sparse.	--	0.6	--
River	4,088	2.3	Active floodplains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands. Widespread, common.	--	0.1	0.0
Rocklea	22,993	12.7	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands. Widespread, very common.	--	--	0.1
Talga	2,124	1.2	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands. North-central, common.	0.0	0.1	0.1
Taylor	129	0.07	Stony plains and isolated hills of sedimentary rocks supporting hard and soft spinifex grasslands. Sparse.	--	--	0.1
Uaroo	7,681	4.2	Broad sandy plains supporting shrubby hard and soft spinifex grasslands. Central north and west, common.	--	0.1	0.1

4.3.2 Major Landforms

4.3.2.1 Project Area

The major landforms described by Van Vreeswyk *et al.* (2004) as being characteristic of the land systems within the project area, and their distribution within the area are:

- *hills and ridges*, major ridge of the Talga Range;
- *low hills and ridges*, minor hills of the Talga Range, predominantly south of the major ridge;
- *lower footslopes*, comprising the scree slopes that dominate the project area to the south of the Talga Range and the northern side of the major ridge;
- *stony plains and interfluves*, predominantly to the north of the major ridge;
- *sandy plains*, predominantly to the north of the major ridge, with small areas adjacent to Coppin Creek in the southern project area; and
- *narrow drainage floors and channels*, comprising the major drainage channel of Coppin Creek, its tributaries and minor drainage channels to the north and south of the Talga Range.

While the greatest proportion of the project area is comprised of the lower footslopes, stony and sandy plains, the area is visually dominated by the major ridge of the Talga Range. The Range extends in an east-west direction across the project area with a maximum height of 324 mASL. The range extends in an east-west direction across this section of the Pilbara for approximately 90 km, and is known as the Gorge Range west of the Talga River. The range dominates the view over long sections of the Marble Bar Road, and is often cut by creeks and rivers forming gaps and gorges such as Doleena Gorge. Hills and ridges associated with the Capricorn and Talga land systems also dominate topography to the east of the project area.

4.3.2.2 Borefields and Service Corridors

Classification of landforms within the borefields and service corridors is based on the broad scale associations with land systems of the region as described by Van Vreeswyk *et al.* (2004), and reconnaissance surveys completed in 2007 (OES 2007a). Landforms described as typical to the land systems within the borefields and service corridors include:

- low hills and ridges;
- low hills and mesas;
- stony slopes;
- stony plains and interfluves;
- sandy plains;
- calcrete plains;
- alluvial plains;
- gilgai plains;
- narrow drainage floors and channels;
- drainage floors and channels; and
- drainage tracts, river terraces, banks and channels.

Plate 4-4 View north over Rocklea land system to Capricorn land system

Plate 4-5 View northeast from Capricorn land system over Macroy land system

Plate 4-6 View south from Capricorn land system, over Rocklea land system to Macroy land system

While the greatest proportion of the borefields and service corridors are comprised of the stony and sandy plains, the areas, particularly along the service corridors, are visually dominated by the low hills, ridges and mesas of the Capricorn, Rocklea, Callawa, Coongimah and Oakover land systems.

4.3.3 Soils

The soils of the Pilbara region have previously been described and mapped at a regional scale by Van Vreeswyk *et al.* (2004), based on characterised land systems of the region.

Comprehensive baseline soil surveys of the project area were conducted during 2005 and 2006 (OES, 2006a, OES, 2006b and OES, 2006c) (**Appendix B**). The soil surveys included the characterisation of soils to the north and south of the Talga Range (OES, 2006a) and detailed investigations of the soil profiles within Coppin Creek (OES, 2006c) and the proposed creek diversion pathway (OES, 2006b) (**Appendix C**). Characterisation of the major soil types within service corridors and water supply areas was also conducted during studies undertaken in 2007 (OES, 2007a). Soil attributes were classified based on the terminology detailed in McDonald *et al.* (1998).

4.3.3.1 Project Area

Soil types described as characteristic of the land systems within the project area (Van Vreeswyk *et al.* 2004) include:

- stony soils;
- red shallow loams;
- red shallow sands;
- red sandy earths;
- red loamy earths;
- calcareous shallow loams; and
- channels of river bed soils.

The baseline soil survey for the project area (OES, 2006a) indicated that the majority of the soil profiles over the slopes and plains to the north and south of the Talga Range show little pedological organisation or structure, with only slight textural differences present through the majority of profiles examined. Most profiles consist of an indistinct and shallow, loamy sand, or clayey sand to sandy loam A-horizon, overlying a B-horizon of similar texture. The soils are typically dominated by a high coarse fraction (>2mm), which generally increases in size and abundance with increasing depth.

The soils exhibit a wide range of pH values (pH 6.3 to 9.6) (1:5, H_2O), with little consistency between soil pH and position within the landscape, or vegetation community. Similarly, landscape position offers little explanation for the electrical conductivity (EC) of materials sampled, the majority of which are considered to be non-saline.

Soil nutrient analyses indicated low nutrient levels (total nitrogen, available nitrogen, phosphorus, potassium and sulphur) that are typical for the region. There is little consistent trend in soil nutrient status in relation to position within the landscape or to vegetation community. As would be expected, the level of all measured nutrients generally decreases slightly with depth in the soil profile.

Analysis of water-soluble metal concentrations in surface soils indicated very low baseline levels. Most materials sampled were below the detectable limit for the bulk of the elements measured, with only aluminium regularly measured at a detectable level. For the metals detected, there was no apparent correlation with landform or vegetation unit.

There is little apparent difference in the physical or chemical properties of surface soils (0-20cm) between the sample sites to the north, and those to the south of the Talga Range.

Coppin Creek

The baseline survey of channel and creek bed soils of Coppin Creek that lies within the project area (OES, 2006c), indicated a wide range of morphological features, variations in soil structure and soil texture, reflecting a dynamic creek system subject to cycles of deposition and erosion. The high degree of soil profile variability was particularly evident for the soils within the creek bed. The surface characteristics within the creek bed vary according to position within the major drainage line and sub-channels, with the structure and texture of the surface soils ranging from single-grained alluvial sands to sandy clay loams with a distinct crust at the surface. The abundance of coarse fragments at the creek bed surface range from very few (<2%) in depositional areas, to abundant (50-90%) and very abundant (>90%), in major channel areas.

Soil textures within the creek bank profiles range from clayey sands (approximately 5-10% clay) to sandy clay loams (20-30% clay), with sandy loams (5% clay) to light clays (35-40% clay) present within the creek bed profiles. Several sites within the creek bed exhibit buried organic soil layers, indicative of historical A-horizons within the current soil profile.

The majority of soil materials from within the creek bed and creek banks are not dispersive, and exhibited low soil strengths upon drying. Soil pH values are classed as moderately to highly alkaline (pH 7.4 to 10.1) (1:5, H_2O), with the surface soils of the creek bed being slightly more alkaline than the surface soils of the adjacent creek banks and surrounding areas (OES, 2006a). Most soils sampled were classed as non-saline.

The amount of bio-available nutrients held within the soils is generally low, being typical of such native soils. The majority of sites exhibit limited trends in nutrient levels (bio-available nitrogen, phosphorus, potassium and sulphur) or levels of organic carbon in relation to position within the creek profile.

Measurements of water-soluble metal concentrations of the samples collected indicated that only very low levels of aluminium, arsenic, cadmium, copper, lead, manganese, molybdenum and zinc are present within the creekline soils. Most materials sampled were below the detectable limit for the bulk of the elements measured, with only aluminium regularly reported at a detectable level. Trace amounts of arsenic, copper and manganese were also detected in a small number of samples. For the metals detected, there was no apparent correlation with sample depth or position within the creek profile.

Coppin Creek Diversion Path

The majority of soils characterised within the minor drainage lines of the proposed Coppin Creek diversion path (OES, 2006b), are similar in terms of physical and chemical characteristics, to the soils within the existing creek.

The surface characteristics of the six sample sites varied according to their position either within, or adjacent to, the minor drainage lines of the study area, with the structure and texture of the surface soils ranging from single-grained loamy sands to aggregated sandy loams. The abundance of coarse fragment cover at the six sites ranged from moderate (approximately 25%) in the broader flat areas, to abundant (50-90%) and very abundant (>90%), in the minor drainage channels sampled.

The soil textures within the soil profiles examined, ranged from loamy sands (approximately 5% clay), to clay loams (30-35% clay). All samples were within the wide range of soil textures exhibited in the survey of the section of Coppin Creek proposed to be diverted. No dispersive soils were identified at the six sampling sites.

As was the case with the soils examined within Coppin Creek, the soils within the diversion path were classed as highly alkaline and predominantly non-saline. The amount of plant-available nutrients (nitrogen, phosphorus, potassium and sulphur) within the soils was low, but at comparable levels to that of the Coppin Creek soils. Similar water-soluble concentrations of aluminium, arsenic, copper and manganese, were found within the soils of the creek bed and banks of the section of Coppin Creek proposed to be diverted.

4.3.3.2 Borefields and Service Corridors

Broadscale soil classification of water supply areas and service corridors has been described by Van Vreeswyk *et al.* (2004) based on characterised land systems of the region. Soil types described as typical to the land systems within the borefields and service corridors include:

- stony soils;
- red shallow sands;
- red shallow loams;
- red loamy earths;
- red sandy earths;
- red deep sandy duplex;
- deep red/brown non-cracking clays;
- calcareous shallow loams; and
- channels with river bed soils.

Characterisation of the major soil types within the service corridors and water supply areas was conducted during studies undertaken in 2007 (OES, 2007a). Soil attributes were classified based on the terminology detailed in McDonald *et al.* (1998).

The baseline soil survey for the borefields and service corridors indicated that the majority of the soil profiles over the areas of the service corridors show little pedological organisation or structure, with only slight textural differences present through the majority of profiles examined. Most surface profiles consist of a shallow loamy, or clayey sand to sandy loam A-horizon, with an irregular, gradual boundary to the B-horizon. The B-horizon often has a higher coarse fraction (>2mm), generally increasing in size and abundance with depth.

The soil materials sampled exhibited a wide range of pH values, with distinct differences in average soil pH existing between the sandy plains of the Canning borefield and the average pH for the other sites examined. Landscape position offered little explanation for the electrical conductivity (EC) of materials sampled, the majority of which were considered to be non-saline.

Soil nutrient analyses indicated low plant-available nutrient levels (N, P, K and S) that are generally typical for the region. There was little consistent trend in nutrient level in relation to position within the landscape. As expected, the level of all measured nutrients generally decreased slightly with depth in the soil profile.

4.3.4 Waste Rock Characterisation

Waste rock characterisation has been undertaken in order to identify any material which may require specific management during operations (**Appendix M**). In particular, the possibility for ARD has been investigated to distinguish PAF material from NAF material.

Three main lithotypes are associated with the orebody at Spinifex Ridge:

- Granodiorite
- Mafic volcanics – basalt, pillowed basalt and dolerite
- Felsic volcanics – quartz or feldspar dominated porphyry, rhyolites, dacite and rhyodacites

It is expected that 100% of the granodiorite will be processed as ore, while much of the felsic and mafic units will be taken as waste to the waste landform or stockpiled as mineralised waste or lowgrade. The waste units in the regolith are highly-leached with little to no sulphur and varying amounts of carbonate (GCA, 2006). The mafic and felsic volcanic bedrocks tend to exhibit trace elements of sulphides with the sulphide minerals; chalcopyrite, pyrrhotite and pyrite occurring particularly in the mafic volcanics (GCA, 2006) (**Table 4-4**). Based on current understanding of the waste geochemistry (GCA 2006) a conservative sulphur level of 0.32% has been used to distinguish between PAF and NAF waste rock. On this basis, modelling of the likely distribution and volume of PAF waste rock (SRK, 2006), supplemented by more-detailed modelling using lithological domains (Mining Assets, 2007), indicates approximately 24.75M dcm of waste rock may require encapsulation. This represents approximately 25% of the total volume of waste rock.

4.4 Geoheritage

A review of the Geological Survey of Western Australia (GSWA) Register of State Geoheritage, undertaken in December 2006, revealed that some 150 sites were recorded on the Register. No sites were found to occur within or in near proximity to the project area. In addition to the review of registered sites, an assessment of key features occurring within the project area has been completed. This assessment is described below.

Although the available definitions of geoheritage are broad, and their application subjective, the one considered most applicable to the project is the following:

> "Those components of geodiversity that are important to humans for purposes other than resource exploitation; things we would wish to retain for present and future generations" (Eberhard, 1997)."

There is a general lack of guidance and standards that assist in determining whether a site is significant from a geoheritage perspective. By way of the definition provided above, the principles captured by the term 'geoheritage' are subjective and are based upon humanistic elements such as the community's association with the area as well as their perception of the area. While some assessments have considered a detailed set of assessment criteria (Cook *et al*., 1997), the adopted approach for this project is simplified and includes an assessment of the local and regional significance, as determined by the presence of:

- any unique or distinct features;
- similar geoheritage features in the local area or wider region; and
- aesthetic, cultural and recreational values.

The following natural features were assessed:

- the Talga Range;
- Kitty's Gap; and
- Coppin Gap.

The Talga Range dissects the project area, stretching west across the Marble Bar Road and east for approximately 25 km to the upper reaches of Bamboo Creek. When compared to surrounding topography of the region, the Talga Range is similar and a smaller representation of the ranges and ridge lines that exist in the Marble Bar area. Its linear nature is very similar to the nearby Black Range located 30 km to the southwest of Marble Bar, which stretches for approximately 65 km. The Black Range is also dissected by drainage lines. The most significant feature across the Black Range is the location where the Shaw River dissects the ridge line and has formed a natural spring in the area (DME, 1975a). The area is accessible via tracks. Other smaller tributaries, such as Garden Creek, have also dissected the ridge line to form "gaps" and some of these are accessible via tracks. The Black Range is a registered geoheritage site.

The northern portion of the Yarrie Station pastoral lease also contains several similar features to the project area including Shay Gap, Cundaline Gap, Cattle Gorge, Kimberley Gap and Kennedy Gap.

Numerous series of ridge lines and ranges occur to the west of Marble Bar. These areas are extensive, covering very large areas and are dissected by the Coongan and Shaw Rivers and its tributaries, forming various ‘gaps’ along the ridge lines.

In comparison to these significant features that occur within the immediate Marble Bar region, the Talga Range is not considered to be a unique or uncommon feature in the local or regional context. The topography of surrounding ranges and ridge lines such as the Black Range provide for similar geoheritage values to exist in areas outside the project area.

Kitty’s Gap is a feature of the Talga Range that has been formed by Kookenyia Creek and is one of a number of similar features within the ranges of the Marble Bar region. Although Kitty’s Gap does contain aesthetic value it does not support any unique or distinct features. Its close proximity to Coppin Gap and accessibility via vehicle encourages visitors to the area.

Coppin Gap on the other hand, in addition to containing aesthetic values, supports semi-permanent water. While pools and springs such as Strelley Pool, Glen Herring Waterhole, Chinaman Pool (a registered geoheritage site), Marble Bar Pool and Nandingarra Pool (DME, 1975b,c) do exist in the Marble Bar region, they are, however, less common. The preservation of Coppin Gap has been routinely raised in consultation with Marble Bar residents and other stakeholders, in particular its value as a tourist attraction. The Njamal People have also advised that Coppin Gap is important from an Aboriginal Heritage perspective. Of the natural features present within the project area, Coppin Gap is a feature containing the most geoheritage value that warrants protection. The preservation of Coppin Gap is discussed in detail in **Sections 8.4 to 8.7**.